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HOW TECHNOLOGY USE IS BEING REFLECTED IN JUNIOR SECONDARY MATHEMATICS TEXTBOOKS IN HONG KONG

Ida Ah Chee MOK

The University of Hong Kong, The University of Southampton

iacmok@hku.hk

The use of digital technologies has been proposed as one of the five basic principles of curriculum design in the curriculum document for the secondary mathematics curriculum (CDI, 1998). Since then, the Hong Kong curriculum has undergone continual reforms of different scales, e.g., "Learning to learn" (EDB, 2001), "The future is now: From vision to realisation" (EDB, 2009), and the use of digital technologies in mathematics teaching has been promoted. Textbook is recognized as the potentially implemented curriculum (Johansson, 2005). To what extent has the technology been used and reflected in the junior mathematic textbooks in Hong Kong? A popular textbook series is analysed. Results are categorized into use of calculators, use of computer software and use of supplementary resources. The use of technology varies according to the topics in the different strands, namely, algebra, geometry and data handling.

INTRODUCTION

The use of digital technologies, including calculators, software and the internet, has been introduced in mathematics education for more than two decades. The first critical attempt to study the influence, potential and constraints in using information and communication technology (ICT) in mathematics education dates back to the International Commission on Mathematical Instruction (ICMI) Study "The Influence of Computers and Informatics on Mathematics and its Teaching" in 1985 (Churchhouse, et al., 1986; Laborde and Sträßer, 2010). Technology is currently widely recognized as essential in enhancing the teaching and learning of mathematics (National Council of Teachers of Mathematics, 2000). In pace with the global trend, the use of digital technologies has been proposed as one of the five basic principles of curriculum design in the curriculum document for the secondary mathematics curriculum (CDI, 1998). Since then, the Hong Kong curriculum has undergone continual reforms of different scales, e.g. "Learning to learn" (EDB, 2001), "The future is now: From vision to realisation" (EDB, 2009), and the use of digital technologies in mathematics teaching has been promoted.

Textbook is recognized as the potentially implemented curriculum (Johansson, 2005). To what extent has the technology been used and reflected in the junior mathematic textbooks in Hong Kong? A popular textbook series is analysed. Results are categorized into use of calculators, use of computer software and use of supplementary resources. The use of

technology varies according to the topics in the different strands, namely, algebra, geometry and data handling.

RESEARCH QUESTIONS

How has the technology been used and reflected in the current junior mathematics textbooks (Grade 7 to Grade 9) in Hong Kong?

Curriculum in Hong Kong

The current mathematics curriculum in Hong Kong for junior secondary level is based on curriculum guide prepared by the Curriculum Development Council (2002). With respect to information technology, the short-term targets with respect to IT is to "use diversified learning activities and tools (including project learning and using IT) to arouse students' interest in learning mathematics and to foster high-order thinking skills" (CDC, 2002, p. 5). The objectives of the curriculum include those for strands or learning dimensions of mathematics knowledge (numbers and algebra; measures, shape and space; and data handling) and generic skills (collaboration, communication, creativity, critical thinking, information technology (IT), numeracy, problem solving, self management and study). The mathematics contents are arranged in learning units under the three learning dimensions (Appendix 1)

Information technology is listed as one of the generic skills. The curriculum framework listed with descriptors of expected achievement across the curriculum and provides exemplars of implementation in mathematics education. The mathematics exemplars are: (p.22):

1. To use scientific calculators/graphing calculators for various computational and exploratory activities (e.g. input data and create statistical graphs; draw straight lines and explore their relationship with slope)
2. To use suitable software to explore the relations of numbers (e.g. number patterns), algebraic formula (e.g. formulae of area and volume) and graphical representations (e.g. pie charts and straight lines)
3. To use suitable software to construct/explore appropriate statistical diagrams/graphs (e.g. bar charts, pie charts, line charts) to represent given data; to find simple statistical measures (e.g. mean, mode) and to explore the meaning of experimental probability (e.g. tossing coin simulation)
4. To use geometry software packages to explore properties of 2-D rectilinear geometric figures dynamically (e.g. the relationship among the angles or sides of a parallelogram); to explore and visualize geometric properties of 2-D and 3-D figures intuitively (e.g. transformation and symmetry)
5. To use the information obtained through Internet/Intranet in self-directed learning and when doing projects (e.g. statistical projects, projects on the development of mathematics in China, stories and achievements of mathematicians)

6. To judge the appropriateness of using IT in solving mathematical problems (e.g. to calculate $2\sin 30^{o}$ mentally)

METHOD

Selection of textbooks:

One of the most popular textbook series used in Hong Kong was selected for the study. Each grade consisted of two volumes with 5 to 7 chapters in each volume and there were about 40 to 60 pages for each chapter. Each volume was accompanied by a CD-ROM.

Coding

The textbooks including the CD-ROM were read from top to bottom to code all examples and activities/exercises that used IT. The coding was based on Fan's framework (2011) and there were mainly three types of using technology:

1. Use of scientific calculators, e.g., to find value, to calculate, and to explore
2. Use of Internet as a resource, e.g., for project work
3. Use of specific software such as excel and GeoGebra for mathematics activities, e.g, to construct graphs, to explore geometric figures.

RESULTS

The CD-ROM

The CD-ROM was designed to be either viewed by resource type or by chapters. When viewed by chapter, only the relevant resources for the chapter were shown. When viewing by resource type, it consisted of the following teaching or self-learning resource items:

- 5-minute lectures which were powerpoint files for selected topics in the chapters.
- Drilling program were self-evaluated drilling exercises matching the content in the chapters that could be run on the computer.
- IT activity provided the pdf files of the activity worksheets and associated Excel or GeoGebra files, that matched the activity suggested in the textbooks.
- Software demonstration included files with screen video and verbal instruction of using the software such as Excel, Sketchpad and GeoGebra. E.g., calculating the mean, mode and median of a group data using Excel, construction of parallelogram with Sketchpad or GeoGebra.
- Glossary was a dictionary for mathematical vocabulary in the textbooks, providing definition and audio.
- "Graph and grid paper" contained files of different scales of graph and grid paper including polar coordinates and isometric grid which could be printed for paper-and-pencil use.

Use of calculators

In general, scientific calculators could be used for all parts of the curriculum. There was an approved list of calculators that could be used for public examinations held by the Hong Kong

Examinations and Assessment Authority. Matching the objectives of the curriculum, students were expected to judge the appropriateness of using calculators for solving mathematical problems. Therefore, there were no specific indication whether students should use calculators or not for a certain problem or exercise in the textbook. However, some guidelines in the format of "keying sequence" were included in the text for demonstrating how to use the function keys in the calculators, e.g., "'sin' 50 'exe'".

Use of internet as a resource

There were two categories of using the internet as a resource. One was to carrying out activities with a project nature. The other was to use the *E-tutor* website support provided by the publisher of the textbooks.

At the end of each chapter, there was a revision exercise with support was provided by the E-tutor on the internet for selected problems, usually the slightly more difficult problems for the topic. Students might refer to the E-tutor for hints and outline of method. The E-tutor also provided a list of the knowledge that they needed to solve the problem that might help the students study further.

Figure 1. An example of E-tutor

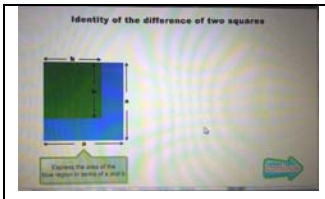
Projects were another type of acitivities that students might use for the internet. Project was not a popular option for the mathematical work suggested in the textbooks, there were only one project for each level. These were: A statistically study on the population in Hong Kong (Grade 7, Data Handling), Pythagoras theorem (Grade 8, Measures, Shapes and Space), and Taxation in Hong Kong (Grade 9, Numbers and Algebra). For example, in the project of Taxation in Hong Kong, students were expected to access the Inland Revenue Department's website to study the tax system and comment on the tax base of Hong Kong. Some guided questions were provided, e.g., "What were the two main sources of tax collection in 2008-2009?" "Present your findings with suitable statistical diagrams, which may include: distribution of various taxes collected in the last three financial years, etc."

Use of specific software such as Excel and GeoGebra for mathematics activities

The use of specific software to provide learning activities depended on the mathematical topics and the softwares included Excel, Sketchpad and GeoGebra with accompany resource materials provided in the CD ROM. The activities were listed in Table 1.

Table 1. IT activities in the textbooks for Grades 7 to 8

Grade 7	Grade 8	Grade 9
• Sum of all the interior angles of a triangle (Geogebra) • Rotational symmetry of plane figures (Geogebra) • Reflection and rotational transformation (Geogebra) • Order of Transformations (Geogebra) • Estimation of π (Excel)	• Identity of the difference of two squares (CD-ROM animation, see figure. 1) • Investigating the graphs of linear equations in two unknowns (Excel) • The value of √2 (Excel) • Tessellation of different figures (link to activity on internet) • Proofs of Pythagoras' theorem(CD-ROM animation) • Properties of sine ratios and cosine ratios (Geogebra)	• Simple interest and compound interest (Excel) • Experimental probability (Excel)



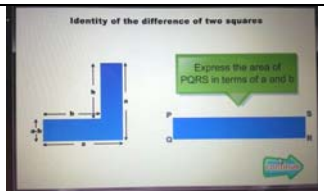


Figure 1. Identity of the difference of two square

Discussion: Impact of technology on mathematics curriculum

The paper discusses how the use of IT was represented in the textbook by an example in Hong Kong. In addition to the use of scientific calculators, the use of IT in the textbooks and it can be categorized into three major categories. The first type is the provision of self-learning platform such as drilling programme with self-evaluation provided by the publishers, that only represented a change of platform for traditional pencil-and-paper test. The second type were IT activities designed to make use of the advantages of specific software platforms such as Excel and Geogebra. These activities often provides opportunities of exploration within a limited context, e.g., proving an identity, tessellation by transformation on a dynamic geometry software environment, exploring the value of π with the help of Excel calculation tools. The third type is to let students to use the internet for mathematical activities with a project nature. The use of IT depends much on the mathematical content stipulated in the curriculum. Textbooks play a very important role of the implementation of the curriculum in Hong Kong (Leung and Park, //). Therefore, the results represent in a certain way the extent implementation of IT in the curriculum as a result of the top-down curriculum reforms.By the design of the textbooks, the use of IT often may be optional. There is still a long way to go in terms of bringing ....

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Appendix 1: The Learning Units for Key Grade 7 to Grade 9 (CDC, 2002, p. 16)

Number and Algebra	Measures, Shape and Space	Data Handling
Directed Numbers and the Number Line	Estimation in Measurement	Introduction to Various Stages of Statistics
Numerical Estimation	Simple Idea of Areas and Volumes	Construction and Interpretation of Simple Diagrams and Graphs
Approximation and Errors	More about Areas and Volumes	Measures of Central Tendency
Rational and Irrational Numbers	Introduction to Geometry	Simple Idea of Probability
Using Percentages	Transformation and Symmetry	
More about Percentages	Congruence and Similarity	
Rate and Ratio	Angles Related with Lines and Rectilinear Figures	
Formulating Problems with Algebraic Language	More about 3-D Figures	
Manipulations of Simple Polynomials	Simple Introduction to Deductive Geometry	
Laws of Integral Indices	Pythagoras' Theorem	
Factorization of Simple Polynomials	Quadrilaterals	
Linear Equations in One Unknown	Introduction to Coordinates	
Linear Equations in Two Unknowns	Coordinate Geometry of Straight Lines	
Identities	Trigonometric Ratios and Using Trigonometry	
Formulas		
Linear Inequalities in One Unknown		